

CLAIMS

1. A method for megasonic cleaning a substrate, comprising the steps of:
 - a) providing a container;
 - b) providing a first megasonic transducer with a first active surface in said container;
 - c) disposing a substrate in said container substantially parallel to and spaced from said first transducer;
 - d) flowing a fluid through said space between the substrate and said first transducer;
 - e) immersing the wafer with said fluid in said container; and
 - f) applying energy to said first megasonic transducer.
2. A method as recited in claim 1, further comprising the step of providing relative motion between said individual substrate and said transducer in a direction substantially parallel to the substrate, while performing said fluid-flowing and energy-applying steps (d) and (f).
3. A method as recited in claim 1, wherein said individual substrate has a substrate surface area and said first active surface has an area at least equal to 40% of the substrate surface area.

- 1 4. A method as recited in claim 1, wherein the substrate has a maximum diameter and
2 said space is in a range from 1% to 80% of said maximum diameter.
- 1 5. A method as recited in claim 1, wherein said space is in a range from 1 micrometer to
2 160 millimeters.
- 1 6. A method as recited in claim 1, wherein said megasonic energy applied to said
2 megasonic transducer has a frequency of at least 400 kilohertz.
- 1 7. A method as recited in claim 1, wherein said megasonic energy applied to said
2 megasonic transducer has a maximum power of at least 400 watts.
- 1 8. A method as recited in claim 7, wherein said megasonic energy is applied to said
2 megasonic transducer with 20% to 100% of said maximum power.
- 1 9. A method as recited in claim 1, wherein said transducer has an area and a total input
2 power and wherein said input power divided by said transducer area is at least four
3 watts per square centimeter.
- 1 10. A method as recited in claim 1, wherein said flowing a fluid step (d) comprises
2 flowing a fluid through said space between the substrate and said transducer at a fluid
3 flow rate sufficient to carry particles away from the substrate before they redeposit on
4 the substrate.
- 1 11. A method as recited in claim 1, wherein said container has a volume and wherein said
2 flowing a fluid step (d) comprises flowing a fluid through said space between the
3 substrate and said transducer at a rate to replace the fluid in said volume in less than

4 or equal to one minute.

1 12. The method as recited in claim 1, further comprising the step of providing a second
2 megasonic transducer with a second active surface in said tank, wherein said second
3 active surface faces said first active surface, and is substantially parallel to and spaced
4 from said first active surface.

1 13. The method as recited in claim 12, wherein in said providing step (b) said first
2 transducer and said second transducer are both completely immersed in said fluid.

1 14. The method as recited in claim 12, wherein said disposing step (c) comprises
2 disposing the substrate in the tank between said first active surface and said second
3 active surface.

1 15. The method as recited in claim 14, wherein said flowing step (d) further comprises
2 flowing the fluid through space between the substrate and the second active surface.

1 16. The method as recited in claim 15, wherein said applying energy step (f) further
2 comprises applying energy to said second megasonic transducer.

1 17. The method as recited in claim 12, wherein said megasonic transducers provide
2 energy to clean both sides and edges of the substrate.

1 18. The method as recited in claim 1, wherein said fluid comprises one of deionized water,
2 dilute RCA cleaning solution and dilute citric acid solution.

1 19. The method as recited in claim 1, wherein in said providing step (b) said active
2 surface is arranged in a horizontal plane.

1 20. The method as recited in claim 1, wherein in said providing step (b) said active
2 surface is arranged in a vertical plane.

1 21. The method as recited in claim 1, wherein in said flowing step (d) fluid is provided in
2 said tank at a lower level than it exits said tank

1 22. The method as recited in claim 1, wherein in said providing step (b) said first
2 transducer is completely immersed in said fluid.

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- 1 23. A method for megasonic cleaning a substrate, comprising the steps of:
- 2 a) providing a container comprising a first megasonic transducer with a first
- 3 active surface, wherein said first megasonic transducer is held in a fixed
- 4 position in said container;
- 5 b) disposing a substrate in said container substantially parallel to and spaced
- 6 from said first active surface;
- 7 c) flowing a fluid through said space between the substrate and said first
- 8 active surface; and
- 9 d) applying energy to said first megasonic transducer.

1 24. A method for megasonic cleaning a substrate, comprising the steps of:

2 a) providing a first megasonic transducer with a first active surface;

3 b) providing a second megasonic transducer with a second active surface facing
4 said first active surface and parallel thereto;

5 c) disposing a substrate between said first surface and said second surface to
6 provide a first space between the substrate and said first surface and a second
7 space between the substrate and said second surface;

8 d) flowing a fluid through said first space and through said second space; and

9 e) applying energy to said first megasonic transducer and to said second
10 megasonic transducer to clean two sides of the substrate.

1 25. A method as recited in claim 24, further comprising the step of providing relative
2 motion between said individual substrate and said transducer in a direction
3 substantially parallel to the substrate, while performing said fluid-flowing and
4 energy-applying steps (d) and (f).

1 26. A method as recited in claim 24, wherein the substrate has a maximum diameter and
2 said space is in a range from 1% to 80% of said maximum diameter.

1 27. A method as recited in claim 24, wherein said space is in a range from 1 micrometer
2 to 160 millimeters.

1 28. A method as recited in claim 24, wherein said megasonic energy applied to said

2 megasonic transducer has a frequency of at least 400 kilohertz.

1 29. A method as recited in claim 24, wherein said megasonic energy applied to said
2 megasonic transducer has a maximum power of at least 400 watts.

1 30. A method as recited in claim 29, wherein said megasonic energy is applied to said
2 megasonic transducer with 20% to 100% of said maximum power.

1 31. A method as recited in claim 24, wherein said transducer has an area and a total input
2 power and wherein said input power divided by said transducer area is at least four
3 watts per square centimeter.

1 32. A method as recited in claim 24, wherein said flowing a fluid step (d) comprises
2 flowing a fluid through said first space and through said second space at a fluid flow
3 rate sufficient to carry particles away from the substrate before they redeposit on the
4 substrate.

1 33. A method as recited in claim 24, wherein said container has a volume and wherein
2 said flowing a fluid step (d) comprises flowing a fluid through said spaces at a rate to
3 replace the fluid in said volume in less than or equal to one minute.

1 34. The method as recited in claim 24, wherein in said providing step (b) said first
2 transducer and said second transducer are both completely immersed in said fluid.

1 35. The method as recited in claim 24, wherein in said disposing step (c) said substrate is
2 completely immersed in said fluid.

1 36. The method as recited in claim 24, wherein said megasonic transducers provide
2 energy to clean edges of the substrate.

1 37. The method as recited in claim 24, wherein said fluid comprises one of deionized
2 water, dilute RCA cleaning solution and dilute citric acid solution.

1 38. The method as recited in claim 24, wherein in said providing step (b) said active
2 surface is arranged in a horizontal plane.

1 39. The method as recited in claim 24, wherein in said providing step (b) said active
2 surface is arranged in a vertical plane.

1 40. The method as recited in claim 24, wherein in said flowing step (d) fluid is provided
2 in said tank at a lower level than it exits said tank

1 41. An apparatus for megasonic cleaning a substrate, comprising:

2 a container for immersing a substrate in a fluid;

3 a first megasonic transducer with a first active surface in the fluid in said
4 container for providing energy to clean the immersed substrate placed
5 substantially parallel to and spaced from said first active surface.

1 42. An apparatus as recited in claim 41, further comprising means for providing relative
2 motion between the substrate and said transducer in a direction substantially parallel
3 to the substrate surface while flowing said fluid and applying said megasonic energy.

1 43. An apparatus as recited in claim 41, wherein the substrate has a major surface area
2 and the substrate is disposed so that said transducer faces at least 40% of said major
3 substrate surface area.

1 44. An apparatus as recited in claim 41, wherein said substrate has a maximum diameter
2 and said space is in a range from 1% to 80% of said maximum diameter.

1 45. An apparatus as recited in claim 41, wherein said space is in a range from 1
2 micrometer to 160 millimeters.

1 46. An apparatus as recited in claim 41, wherein said megasonic energy applied to said
2 megasonic transducer has a maximum power of at least 400 watts.

1 47. An apparatus as recited in claim 28, wherein said megasonic energy is applied to said
2 megasonic transducer with 20% to 100% of said maximum power.

1 48. An apparatus as recited in claim 41, wherein said transducer has a transducer area and
2 a total input power and wherein said input power divided by said transducer area is at
3 least four watts per square centimeter.

1 49. The apparatus as recited in claim 41, further comprising a second megasonic
2 transducer with a second active surface in said tank, wherein said second active
3 surface faces said first active surface and is substantially parallel to and spaced from
4 said first active surface for cleaning both sides of a substrate and edges of a substrate
5 placed between said first active surface and said second active surface.

1 50. The apparatus as recited in claim 49, wherein said first transducer and said second
2 transducer are disposed vertically.

1 51. The apparatus as recited in claim 49, wherein said first transducer comprises an array
2 of transducers.

1 52. The apparatus as recited in claim 51, wherein said array of transducers are disposed
2 horizontally and wherein openings between transducers permit fluid to flow there
3 through.

1 53. The apparatus as recited in claim 49, wherein said first transducer is in a fixed
2 position and said second transducer is moveable.

1 54. The apparatus as recited in claim 49, wherein said first transducer and said second
2 transducer are both completely immersed in said fluid.

1 55. The apparatus as recited in claim 41, wherein said fluid comprises one of deionized
2 water, dilute RCA cleaning solution and dilute citric acid solution.

1 56. The apparatus as recited in claim 41, wherein said first active surface is arranged in a
2 horizontal plane.

1 57. The apparatus as recited in claim 41, wherein said first active surface is arranged in a
2 vertical plane.

1 58. The apparatus as recited in claim 41, wherein said first transducer is completely
2 immersed in said fluid.

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